APPLICATION FOR LETTERS PATENT

TO ALL WHOM IT MAY CONCERN;

BE IT KNOWN THAT, I, HORACE P. HALLING, citizen of the United Kingdom and resident of the United States of America, have invented certain new and useful improvements in a METALLIC SEAL of which the following is a specification.

BACKGROUND OF THE INVENTION

The present invention relates to a metallic seal for the containment of high pressure fluids, including gases, from cryogenic to highly elevated temperatures. More particularly, the present invention relates to pressure-energized, annular metallic lip seals with lateral offset, angular and axial misalignment capability.

In the field of fluid containment of high pressure fluids, resilient metallic seals are employed in applications where elastomeric and polymeric materials cannot be used because of extremely high pressures, high temperatures and/or aggressive media. Such sealing devices are produced in different configurations designed to meet a variety of operating requirements.

One such seal is the "Axial C-Seal", a partial cross-section of which is shown in Figure 1 which was developed as an improvement in flexibility over the hollow metal o-ring. Like the metal o-ring, the axial c-seal may be used to seal gaps between cylindrical surfaces, in mainly static applications.

Other seals have been developed to perform this function, for example, those shown in the following U.S. Patents: 4,457,523; 4,854,600; 5,799,954; 6,257,594; and 6,446,978. All of these seals serve their purpose, but have limitations when required to be both pressure-energized and capable of accommodating significant misalignments of the cylindrical surfaces to be sealed.

In devices known as couplings, a rigid hollow proboscis or probe is inserted into a hollow receptacle in a fluid transmission system. The receptacle contains a sealing ring or multiple sealing rings, which are dilated by the inserted probe, thereby creating the required contact stresses to achieve fluid containment between the two bodies to be sealed together.

C-seals are presently employed in couplings. Occasionally, due to imperfect field installation practices, the probe will be forced into the receptacle before the centerlines or axes of the two components are properly aligned. When this occurs, the probe may dent one side of the c-seal, which may not be sufficiently resilient to elastically deform, and therefore may leave a gap on the opposite side which results in leakage of fluid when the joint is pressurized.

It is highly desirable to provide an improved metallic seal which overcomes the foregoing problems.

SUMMARY OF THE INVENTION

In accordance with the present invention it has now been found that a metallic seal has been provided which obtains the foregoing objectives.

The metallic seal of the present invention has a C-shaped portion which connects to a longitudinally extending portion. The c-shaped portion desirably has a discrete radius with a smaller radius than the axial c-seal, to prevent contact between the probe

and this relatively rigid area during installation. The inside diameter of the c-shaped portion is desirably extended axially towards the end of the c-shaped portion and towards a first end of the seal, and slightly inwardly, desirably terminating in a small inwardly curled portion forming a lip. The opposed portion of the c-shaped portion connects to a longitudinally extending portion which extends above or beyond the c-shaped portion and which desirably terminates in a small outwardly curved portion. The overall configuration of the seal is somewhat L-shaped, or J-shaped.

Further features and advantages of the present invention will appear hereinbelow.

BRIEF DESCRIPTION OF THE DRAWINGS

The present invention will be more readily understandable from a consideration of the accompanying drawings, wherein:

Figure 1 is an enlarged cross-sectional view of a prior art axial c-seal;

Figure 2 is an enlarged cross-sectional view of one embodiment of the seal of the present invention;

Figure 3 is an enlarged side view of a further embodiment of the seal of the present invention;

Figure 4 is an enlarged schematic cross-sectional view of the installation of the seal of the present invention;

Figure 5 is an enlarged schematic cross-sectional view of a seal of the present invention installed, with the axis of the probe displaced to the right;

Figure 6 is an enlarged schematic cross-sectional view of an installed seal of the present invention with the axis of the probe displaced to the left; and

Figure 7 is an enlarged schematic cross-sectional view of an installed seal of the present invention at operating pressure.

DETAILED DESCRIPTION OF PREFERRED EMBODIMENTS

Referring now to the drawings in detail, Figure l shows an enlarged end view of a prior art axial c-seal 10, showing an arcuate portion 12, outer sealing line 14 and inner sealing line 16.

Figure 2 shows an enlarged end view of one embodiment of a seal 20 of the present invention showing an arcuate portion 22, outer sealing line 24 and inner sealing line 26. In addition, the seal 20 of Figure 2 includes an inward curl 28 at one end of the arcuate portion which forms a return 29 at a first edge 30 of seal 20, and the opposed end of the arcuate portion connects to an inwardly tapering frustro-conical portion or longitudinally extended portion 32 which terminates in an outward curved portion 34 to the second opposed edge 36 of seal 20. The function of the return is to provide

stiffening and a lead-in which facilitates assembly for the smooth insertion of the seal into the external cavity during installation.

Figure 3 shows an enlarged side view of a seal 40 of the present invention showing the arcuate portion 42, an inwardly tapered frustro-conical portion 44, inward curl 46 and outward curl 48. A first portion 50 is connected to a second portion 52 of seal 40 by longitudinally extending body portion 54, which depicts a preferred longitudinally extending body of the seals of the present invention. The embodiment of the seal shown in Figure 3 includes a material taper 56 at the frustro-conical portion 44 wherein the thickness of the material forming the seal decreases to increase the flexibility of the seal.

The preferred materials for the seals of the present invention include nickel super alloys and nickel cobalt alloys, although other metals may be used.

The seals of the present invention have several significant advantages. Thus the flexibility of the inward facing lip 29 is enhanced by increased distance from the more rigid c-shaped part of the section and it can be deflected radially by a lower force.

In addition, the configuration of the frustro-conical portion 44 may be reshaped by deflecting relatively easily to accommodate an off-center probe without plastic deformation of this region.

Still further, the seal of the present invention may be manufactured from a thicker material stock from that of the prior art axial-c-seal if desired without an appreciable

increase in insertion force or galling tendencies.

In addition, greater material thickness and a close proximity between the installed probe and the deflected inner frustro-conical leg of the ring cross-section enables higher operating and proof pressures to be sustained without gross permanent deformation.

Also, the seals of the present invention have enhanced reliability. Multiple insertions of the probe into the seals have been a problem for prior art seals.

A further advantage of the seals of the present invention is a tapered cross-section of the frustro-conical portion. This even more flexible feature is advantageous for dynamic, sliding applications, albeit at slow speeds because of reduction of contact stresses.

Figure 4 is an enlarged, schematic side view of the installation of the seals of the present invention showing the insertion of a seal of the present invention in the body of a coupling. Figure 4 shows seal 60 installed in body 62 of a coupling, with retaining wall 64 positioned adjacent the seal and probe 66 spaced from the seal. Figure 5 shows an alternate seal 70 having an outward curved portion 72 and frustro-conical portion 74. The seal 70 is installed in an interference relationship with body 62 and axial retaining wall 64, with probe 66 inserted in contacting, interfering relationship with the seal adjacent to the frustro-conical portion. Elastic deflection of the seal inner lip and tapered frustro-conical portion permits lateral offset of the probe without leakage. In Figure 5 the axis of probe 66 is displaced to the right vis-à-vis body 62; whereas the embodiment of

Figure 6 shows a relationship similar to Figure 5 and depicts the axis of the probe displaced to the left vis-à-vis body 62, widening the gap between body 62 and the frustro-conical portion 74.

Figure 7 shows an enlarged schematic side view similar to Figure 5 of an installed seal 60 at an exemplificative high operating pressure of 30,000 psi deflecting the walls of the seal wherein the seal 60 is not completely deformed. The darker areas 80 on the body 62, retaining wall 64 and probe 66 show higher stress contact regions.

Naturally, variations in the seal are contemplated. For example, the longitudinally extending portion could be conical or have a slight curve. The c-shaped portion could have variations and flats and need not be uniform. All shapes could be slightly irregular.

Various coatings, including silver or gold, may be beneficially applied to the seal or its contact surfaces in order to improve its sealing efficiency. For dynamic applications special anti-galling, low-friction coatings may be applied. Thus, sealing contact areas may be coated with soft, lubricious and/or anti-galling materials.

It is to be understood that the invention is not limited to the illustrations described and shown herein, which are deemed to be merely illustrative of the best modes of carrying out the invention, and which are susceptible of modification of form, size, arrangement of parts and details of operation. The invention rather is intended to encompass all such modifications which are within its spirit and scope as defined by the claims.